chloric acid, the calcium and strontium being then separated by other reagents.

All the above, as far as concerns the carbonates, is modified slightly by the hydrolytic dissociation which takes place in the solutions. The relations, however, between the carbonates and sulphates will remain unchanged since the hydrolytic dissociation will take place to nearly the same extent in the solutions of all three.

REVIEW.

A BRIEF HISTORY OF THE MOVEMENT FOR INCREASING THE ACCURACY AND FOR IMPROVING THE CONSTRUCTION OF CHEMICAL MEASURING INSTRUMENTS.

The greater part of the matter contained in this paper was compiled for the use of the "Committee on Standards for Chemical Measuring Instruments" of this society and formed a part of that committee's report, which was read at the New York meeting in December last, and which is now before the committee for the reconsideration of some minor details, in accordance with a promise made to a minority of the committee. I may state, however, that the committee has unanimously agreed to the proposition that the society extend a formal invitation to the U. S. Office of Standard Weights and Measures to adopt regulations governing the construction, calibration, and testing of volumetric apparatus, similar to the regulations of the Kaiserliche Normal-Aichungs-Commission of Germany. This was the most important recommendation contained in the report of the committee as presented at New York, and it will soon be before the council of the society for action.

It is at the suggestion of my fellow members of the committee that I now present the following data in this form.

THE WORK OF EUROPEAN CHEMISTS.

As early as 1891, the "Deutsche Gesellschaft für angewandte Chemie" and the "Verein deutschen Eisenhüttenleute" had taken up the question of standards for chemical measuring instruments, and it was with the assistance and coöperation of these associations that the excellent regulations of the German Normal-Aichungs-Commission for testing volumetric apparatus were perfected and finally adopted. These regulations, as published in 1893, were as follows:

NOTICE IN REGARD TO THE TESTING OF CHEMICAL MEASURING FLASKS, ETC.

[From Zeitschrift für angewandte Chemie, 1893, pp. 557-559].

The Kaiserliche Normal-Aichungs-Commission published the

following directions, based upon article 18 of the regulations governing weights and measures (special supplement to Reich's Gesetzblattes, No. 30) :

I. ALLOWABLE MEASURING APPARATUS.

1. For exclusive use for chemical volumetric analysis of aqueous solutions, glass vessels will be admitted for testing as follows :

Vessels with one mark to hold a single volume.

(*a*) Flasks.

(*b*) Pipettes with upper suction tube and a lower delivery tube.

Vessels marked to hold a certain definite volume and certain subdivisions thereof.

(*c*) Measuring glasses (also called measuring cylinders, being measuring tubes having a foot).

(*d*) Burettes (measuring tubes without a foot, but with a delivery tube).

(*e*) Measuring pipettes (measuring tubes having a suction tube at the upper end and a delivery tube at the lower end).

2. The capacity of a measuring vessel is to be limited either by the mark or the lower opening, and its quantity is marked upon the vessel for a temperature of a vessel of 15° of the centigrade thermometer, in the liter, fractions of a liter, or in cubic centimeters, in which case the cubic centimeter is to be the 1-1000 part of a liter.

3. Measuring vessels may be graduated either to hold (*messgeräthe auf Einguss*) a given quantity to the mark, or to deliver (*messgeräthe auf Ausguss*) a given quantity. Measuring vessels provided with a device for the delivery of liquids must always be graduated to *deliver* the volume of liquid for which they are marked. Other vessels may be graduated to either hold or to deliver, but for only one of these purposes in the case of any single vessel. The volume of liquid is measured with a delivery apparatus by filling and emptying, with precautions to retain a uniformly unpreventable moistening of the walls of the vessel. This uniform moistening is insured by observing the following precautions:

(*a*) Measuring vessels which are emptied by turning up-side-down are held for one minute after emptying in an inclined position to allow them to drain, when the last drop is wiped off.

(*b*) In the case of pipettes the liquid is allowed to flow out entirely, or to the lower mark, according to the method of graduation, while the delivery tube is held without motion in contact with the sides of the receiving vessel. After the free outflow of the liquid has stopped, or after the lower mark has been reached, the pipette is allowed to drain for one-quarter of a minute.

(*c*) In the case of burettes, or measuring pipettes (pipettes graduated to deliver fractions of their maximum capacity), the desired quantity is drawn out, the last drop is removed, and the reading is taken off after waiting two minutes.

4. The cross-section of the measuring vessel must always be circular. The space occupied by the liquid to be measured, viewed in the direction of its greatest diameter, should decrease in size above and below, best at the same rate. Where the body of the vessel has a tube or cylindrical portion sealed on, the body of the vessel must gradually merge into the cylindrical portion without any abrupt change of direction, so that there will be no hindrance to the ready outflow of the liquid.

5. The mark shall be narrow, and both it and the label shall be plainly etched, ground, or applied in some other permanent manner. It should never be merely painted. The mark should always be upon a cylindrical, regularly formed, transparent part of the vessel. Coloring the mark is permitted.

6. The mark shall pass at least halfway around the vessel and lie in the plane to which the axis of the vessel is perpendicular.

7. In the case of measuring vessels marked for subdivisions of their total capacity, these subdivisions must all be equal.

8. Capacity of a flask may be stated in liters or cubic centimeters (the mark being *liter*, *l.*, or *cc.*), while all other vessels may be marked only cubic centimeters—*i. e.*, with the mark *cc.* The mark expressing the capacity of a vessel without subdivisions, is placed on the middle part of the body of the vessel.

9. The numbers of the marks on vessels marked for subdivisions of their total capacity, are to be placed at the right end of the lines denoting cubic centimeters as units. These numbers must run consecutively and in only one direction; *i. e.*, either from the top down or from the bottom up.

The "cc." mark is added to the line bearing the largest number, whether it be at the beginning or at the end of the graduation.

10. There must be etched below the mark indicating the capacity, in the case of flasks and other vessels having but one graduation mark, the expression $+15^{\circ}$ C., indicating the temperature at which the capacity of the flask is equal to the volume indicated by its label. In the case of instruments graduated for fractions of their total capacity, this mark ($+15^{\circ}$ C.) is etched at least 15 mm. above the graduation. There must also be placed at the left of this mark and at the same height the mark *E.* or *A.*, *Eing.* or *Ausg.*, *Einguss* or *Ausguss*, as the case may be, to indicate whether the instrument has been graduated to hold or to deliver the volume of liquid indicated by its label.

A manufacturer's number, name, and address, and a trade mark may be placed opposite the label mentioned above on the

other side of the flask. In the case of apparatus graduated for subdivisions the manufacturer's marks are to be placed in long lines at the left of the graduation.

11. In the case of all measuring vessels the reading shall be taken at that point of the wall of the vessel where it is cut by the plane which is perpendicular to the axis of the vessel and at the same time tangent to the meniscus of the liquid at its lowest point.

12. Inflow and outflow tubes, stoppers, etc., must not end in the measuring space of the vessel or extend therein. The limiting of the measuring space directly by cocks is inadmissible. Beyond the part actually occupied by the liquid to be measured the vessel may be provided with cocks, tubes, expansions made of irregular form, etc., *ad libitum*.

13. In the case of measuring vessels having a delivery tube or point, the latter should be drawn out as thin as stability will permit, and its termination should be smooth and even. It is permissible to constrict the orifice somewhat. In the case of burettes of the Gay-Lussac form, the delivery point should be bent back toward the delivery tube, and should be ground obliquely on the under side.

II. Measuring Vessels without Minor Graduation.

(Flasks and pipettes graduated to deliver one maximum volume).

1. Flasks may be made of the following capacities: 2, 1, $\frac{1}{2}$(0.5), $\frac{1}{4}$(0.25), 0.2, 0.1, and 0.05 liter; pipettes, of any desired capacity from 1 to 200 cc.

2. In the case of both forms of apparatus the part bearing the graduation mark must be cylindrical (see above, I, 5), of uniform section, and transparent. Moreover, this cylindrical portion must pass over very gradually into the expanded part of the apparatus.

3. In the case of pipettes the suction tubes must be at least 130 mm. long, and the delivery tubes at least 60 mm., but not more than 300 mm. long.

4. The graduation mark must be at least 70 mm. from the upper end of the neck of a flask, and in the case of a pipette at least 100 mm. from the upper end and at least 30 mm. from the bulb. The mark must extend entirely around the neck of the flask or the suction tube of the pipette.

5. At the point where the graduation mark is placed the internal diameter of the neck of the flask shall not be less than 6 mm., and shall not exceed the following maximum figures given for flasks of each of the sizes admitted for testing:

Capacity of flask. Liters.	Maximum internal diameter of neck. mm.
2	25
1	20
$\frac{1}{2}$(0.5)	20
$\frac{1}{4}$(0.25)	15
0.2	12
0.1	12
0.05	10

In the case of pipettes the suction and delivery tubes must have an internal diameter of not less than $\frac{1}{2}$ mm. and not more than 6 mm.

6. The bottom of the flask may be slightly reentrant. The circumference of the bottom of the flask must form a plane to which the neck of the flask is perpendicular. The flask must stand solidly on a horizontal surface.

7. The lower limit of the volume of a pipette may be either the end of the delivery tube or a second mark etched thereon at least 30 mm. from the end.

In the case of pipettes without a cock, the delivery orifice must be of such a size that the discharge of the pipette, conformable to I, 3, (*b*), lasts:

12 to 15 seconds when the pipette is of less than 10 cc. capacity.

15 to 20 seconds when the capacity of the pipette is of 10 cc. or more but less than 50.

20 to 30 seconds when the capacity of the pipette is 50 cc. or more but less than 100.

30 to 40 seconds when the capacity of the pipette is 100 cc. or more.

In the case of pipettes provided with cocks, the testing must be made for that setting of the cock which requires the following time for emptying the pipette:

13 to 17 seconds when the capacity of the pipette is less than 10 cc.

16 to 20 seconds when the capacity of the pipette is 10 cc. or more but less than 50.

23 to 27 seconds when the capacity is 50 cc. or more but less than 100.

33 to 37 seconds when the capacity of the pipette is 100 cc. or more.

III. Measuring Vessels with Minor Divisions.

1. The total volume of vessels graduated for subdivisions thereof may have any value between 1 cc. and 1 liter, but for cylinders and burettes shall not be less than 5 cc., and for burettes and pipettes not more than 100 cc.

2. The subdivisions permitted are as follows:

When the total capacity of the apparatus is 1 cc. and up to and including 2 cc., the smallest subdivision is 0.01 to 0.02 cc.

When the total capacity of the apparatus is more than 2 and up to and including 5 cc., the smallest subdivision is 0.05 to 0.02 cc.

When the total capacity of the apparatus is more than 5 and up to and including 10 cc., the smallest subdivision is 0.05 to 0.1 cc.

When the total capacity of the apparatus is more than 10 and up to and including 50 cc., the smallest subdivision is 0.1 to 0.2 cc.

When the total capacity is more than 50 and up to and including 100 cc., the smallest subdivision is 0.2, 0.5, or 1 cc.

When the total capacity is more than 100 and up to and including 200 cc., the smallest subdivision is 1, 2, or 5 cc.

When the total capacity is more than 200 and up to and including 500 cc., the smallest subdivision is 5 to 10 cc.

When the total capacity is more than 500 cc., the smallest subdivision is 10 cc.

3. The measuring space may be limited by lines below as well as above. In the case of pipettes, the upper graduations must be at least 100 mm. from the upper end of the apparatus and at least 50 mm. in other cases. The lower mark of the graduation, in cases where the bottom of the vessel is not the lower limit of the graduation, must be at least 30 mm. from the lower end of the apparatus or from the beginning of the contraction of the body thereof.

4. The numbering is to be done as follows:

(*a*) In case of division into 10, 1, 0.1, or 0.01 cc., every tenth mark is numbered.

(*b*) In case of division into 2, 0.2, or 0.02 cc., every fifth line is marked.

(*c*) In case of division into 5, 0.5, or 0.05 cc., every second or tenth line is marked.

The numbered lines must extend entirely around the vessel. Of the other lines, the fifth in the case "a" and whenever only every tenth line is numbered, and the first line when every second line is numbered, must extend three-fifths of the way around the vessel, while all other lines extend only one-half way around.

All lines not passing entirely around the vessel must be on transparent glass; any opaque strips for facilitating the reading of the instrument must not be greater in breadth than two-fifths of the circumference of the tube.

5. The distance between two consecutive division marks must not be more than 12 mm., and for measuring cylinders graduated for each 5 cc. or more, not less than 2 mm., while for all

other measuring vessels this distance must not be less than 1 mm.

IV. Limit of Error.

1. Measuring vessels without divisions.

For flasks graduated for delivery the error must not exceed the following limits:

Capacity. Liters.	Allowable error. cc.
2	1
1	0.6
0.5	0.3
0.2	0.2
0.1	0.2
0.05	0.1

For flasks graduated to hold the quantities of liquid just named, the allowable error is one-half as great in each case.

For pipettes delivering only maximum quantity, the allowable errors are as follows:

Capacity of pipette. cc.	Allowable error. cc.
1 to 2	0.01
More than 2 to 10	0.02
More than 10 to 30	0.03
More than 30 to 75	0.05
More than 75 to 200	0.1

2. Measuring vessels with divisions—burettes and pipettes.

Maximum capacity. cc.	Allowable error on maximum capacity. cc.
1 to 2	0.01
More than 2 to 10	0.02
More than 10 to 30	0.03
More than 30 to 50	0.05
More than 50 to 100	0.1

In the case of graduated cylinders of the dimensions just given, the allowable error is double that for burettes and pipettes when the instruments are graduated to hold a certain volume, but four times as great as the errors allowed for burettes and pipettes when graduated for delivery or pouring out.

For larger measuring cylinders graduated to hold definite volumes, the allowable errors are as follows:

Maximum capacity. cc.	Allowable error. cc.
More than 100 to 200	0.5
More than 200 to 500	1
More than 500	2

When graduated for delivery or pouring, the allowable errors are just twice as great.

For measuring cylinders graduated to hold a definite volume, the maximum errors for the volumes indicated by ten of the consecutive smallest divisions must on no part of the graduation be greater than as shown below.

1 cc. when the divisions equal 10 or 5 cc.

0.4 cc. when the divisions equal 2 cc.

0.2 cc. when the divisions equal 1 or 0.5 cc.

0.1 cc. when the divisions equal 0.2 or 0.1 cc.

In the case of cylinders graduated for delivery, double these errors are allowed. In the case of burettes and pipettes graduated to 0.01 to 0.2 cc., the error must not be greater than one-third of the smallest division, and not more than one-fourth of the smallest division in other cases.

V. Stamping.

The official stamp is etched upon flasks immediately over the graduation mark and also over the label. On pipettes graduated to deliver one maximum volume the official stamp is etched immediately over the upper mark and immediately under the lower mark, when there is one.

In the case of other measuring vessels the official stamp is placed close above the upper mark and close below the lower one; besides this, the stamp is also placed on the delivery tube, close to its end.

VI. Fees for Testing.

The fees are as follows:

(*a*) For testing and placing the official stamp on measuring vessels without divisions, 30 *pf.* ($0.072).

Measuring vessels having divisions, 80 *pf.* ($0.192).

(*b*) For mere testing, for each complete volume or each mark tested, 10 *pf.* ($0.024).

If a vessel having divisions is tested for more than 5 marks besides the one indicating the total volume, each additional mark tested is charged for at the rate given under *b*.

VII. Place of Testing.

The testing and stamping of measuring vessels will be done by the Normal-Aichungs-Commission until further notice.

Kaiserliche Normal-Aichungs-Commission, Huber.

Berlin, July 26, 1893.

Supplemental regulations were adopted by the Aichungs-Commission in 1897 as follows:

ADDITIONAL REGULATIONS FOR THE TESTING OF CHEMICAL MEASURING INSTRUMENTS, ADOPTED BY THE KAISERLICHE NORMAL-AICHUNGS-COMMISSION, JULY 2, 1897.

[Zeitschrift für angewandte Chemie, (*1897*), 643-647; Zeitschrift für analytische Chemie, (*1898*), **37**, Amtliche Verordnungen und Erlasse, 2-6.]

I. Additional Forms of Apparatus Admitted for Testing.

In addition to the forms of measuring instruments for exclusive use for chemical analysis of aqueous solutions, mentioned in the notice of July 26, 1893,[1] the following forms will now be accepted for testing:

a. For use in sugar analysis, flasks with two marks and flasks with one mark, or with two marks for a temperature of 20° (Section II).

b. Flasks for use with viscosimeters with two marks for a temperature of 20° (Section III).

c. Flasks with capacities of 150, 300, 350, 400, 450, 550, 600, 650, 700, 750, 800, 850, and 950 cc. (Section IV).

d. Measuring vessels with incomplete graduation (section V).

e. Overflow pipettes (Section VI).

The forms of apparatus mentioned under *a* to *e* shall meet the requirements of the regulations announced July 26, 1893, in so far as the paragraphs here following do not conflict therewith.

II. Flasks for Sugar Analysis.

1. These flasks must be graduated to hold the volumes indicated by their labels, and may have capacities of 50, 100 or 200 cc. A second mark may be placed above the one which marks the limit of the capacity of the flask. These two marks must be separated at least 10 mm. in the case of 50 and 100 cc. flasks; and at least 30 mm. in the case of 200 cc. flasks.

Between the two marks the neck of the flask may be enlarged, provided that it is cylindrical for at least 3 mm. above the lower mark and for at least 3 mm. below the upper mark. The capacity limited by these two marks must not be greater than the tenth part, nor less than the two-hundredth part of the capacity of the flask as limited by the lower mark.

2. Besides the label *E*, or *Eing.*, or *Einguss*, the standard temperature, +15° C. or +20° C., shall be etched upon the flask (Section 1, 10, of the regulations of July 26, 1893). The label indicating the capacity of the flask must be etched upon the body of the flask; and, in the case of flasks with two marks, must denote the capacity of the flask as limited by the lower mark. Flasks with two marks must have, in addition, a label etched midway between the two marks and indicating the capacity of

[1] *Reichs-Gesetzblatt*, Beilage No. 30.

the space included between them, stated in cc. or in fractions of a liter.

3. The internal diameter of the neck of the flask must not be greater than 10 mm. for 50 cc. flasks; not greater than 12 mm. for 100 cc. flasks; and not greater than 25 mm. (15 mm?)[1] for 200 cc. flasks.

4. In the case of flasks with two marks, the upper mark must be at least 50 mm. from the upper end of the neck; in the case of flasks with one mark, the mark must be at least 50 mm. from the upper end of the neck for 50 and 100 cc. flasks, and at least 70 mm. for 200 cc. flasks.

5. The limits of error prescribed by Section IV, 1, of the regulations of July 26, 1893, for flasks graduated to hold 50, 100, and 200 cc. must not be exceeded by sugar flasks of the same respective capacities.

In the case of flasks with two marks, the limit of error of the volume included between the two marks is one-half of that permitted for the entire capacity of the flask.

6. The stamping is to be done in the manner prescribed for flasks at present admitted for verification. In the case of flasks with two marks, however, a second stamp is to be placed above the upper mark. The stamp for the lower mark may be etched directly under the lower mark.

7. The fees will be, in addition to the regular fee of 10 *pf.* for each piece of apparatus presented for verification:

a. For testing and stamping flasks:

Flasks with one mark, 40 *pf.* ($0.096);

Flasks with two marks, 60 *pf.* ($0.144).

b. For mere testing:

For each mark tested, 10 *pf.* ($0.024).

III. Flasks for Viscosimetry.

1. These flasks are only to be graduated to deliver the volumes indicated by their labels; and are to be made only with two marks, one for 200 cc. and one for 240 cc. Between the two marks the neck of the flask may be expanded in the form of a bulb, but it must still be cylindrical for at least 3 mm. above the lower mark and for the same distance below the upper mark.

2. The internal diameter of the neck must not exceed 20 mm. at either mark.

3. In addition, the requirements of Section II, paragraphs 2 and 4 to 7 must be fulfilled with the restriction that the label is to be *A*, or *Ausg.*, or *Ausguss*, and + 20° C.; and the limits of error are to be those of flasks graduated for pouring out.

[1] In the regulations as copied in *Ztschr. angew. Chem.*, this number is 25 mm., while in *Ztschr. anal. Chem.* it is 15 mm. See references above.

IV. OTHER FLASKS.

In view of the additional forms of apparatus admitted for testing by Section I, *c*, the regulations of July 26, 1893, in so far as they refer to flasks, are amended as follows:

Section II, 5. At the point where the graduation mark is placed, the internal diameter of the neck must not be less than 6 mm., and must not be greater than 10 mm for 0.05 l. flasks; not greater than 12 mm. for 0.1 to 0.2 l. flasks; not greater than 15 mm. for 0.25 to 0.45 l. flasks; not greater than 20 mm. for 0.5 to 1 l. flasks; and not greater than 25 mm. for 2 l. flasks.

Section IV, 1. The positive or negative error for flasks graduated for delivery must not exceed 1 cc. for 2 liter flasks; 0.6 cc. for flasks delivering from 1 to and including 0.55 liter; 0.3 cc. for flasks delivering from 0.5 to 0.3 liter; 0.2 cc. for flasks delivering 0.25 to 0.1 liter; and 0.1 cc. for 0.05 liter flasks.

In the case of flasks graduated to hold the volumes named, the respective limits of error must not exceed half the amounts named.

V. MEASURING VESSELS WITH INCOMPLETE GRADUATION.

1. The lowest marks of these instruments, which may or may not be provided with a foot, limits an unsubdivided cylindrical or bulb-shaped space having a capacity of a certain number of whole cc.

2. When this lower space is bulb-shaped, that portion of it extending downward from the graduation mark must be cylindrical for at least 15 mm.

If the vessel is enlarged above the upper mark, the enlargement must begin at least 30 mm. from the upper mark.

3. The graduation of these vessels shall be done in the manner described for measuring glasses of forms previously admitted for testing, in accordance with which the number placed opposite the lowest mark indicates the capacity of the ungraduated part. In determining the graduation permissible (Section III, 1 and 2, of the regulations of July 26, 1893), the space included between the upper and lower marks is to be considered the total capacity, but neither this space nor the lower ungraduated space may exceed 100 cc.

4. The stamp placed underneath the lowest mark attests also the accuracy of the ungraduated portion.

VI. OVERFLOW PIPETTES.

1. Overflow pipettes are pipettes whose capacities are limited above by the end of the upper tube instead of by a mark placed

thereon. The apparatus may be otherwise constructed like ordinary pipettes, the filling being done by means of the delivery tube; or a special tube for the entry of the liquid to be measured may be provided, both the inflow and outflow tubes being controlled by the same cock.

2. The end of the upper tube must be even; its internal diameter must not be greater than 3 mm. in the case of pipettes delivering 500 cc. or less, and not greater than 5 mm. in the case of pipettes of larger capacity. The upper tube must not be longer than 75 mm.; the lower tube not longer than 150 mm. Overflow pipettes may have any capacity between 1cc. and 2000 cc.

3. The time of emptying of overflow pipettes delivering from 1 to 200 cc. must be the same as the time prescribed for ordinary pipettes of the corresponding capacity; for pipettes delivering more than 200 cc. to 500 cc., the time of delivery must be 55 to 65 seconds; for pipettes delivering more than 500 cc. to 1000 cc., 110 to 130 seconds; and for pipettes delivering more than 1000 cc., 170 to 230 seconds (200 seconds?).[1]

4. The limits of error allowable for overflow pipettes of capacities from 1 cc. to 200 cc. are those prescribed for ordinary pipettes of the corresponding capacities; for pipettes delivering more than 200 cc. to 500 cc., the limit of error allowable is 0.2 cc.; for pipettes delivering more than 500 cc. to 1000 cc., 0.3 cc.; for pipettes delivering more than 1000 cc. to 2000 cc., 0.5 cc.

5. There shall be placed upon overflow pipettes at least three stamps. One of these shall be placed over the label, the second one immediately below the upper end of the upper tube, and the third one on the outflow tube close to its end.

In case the capacity of the pipette is limited below by a mark on the outflow tube, a fourth stamp must be placed immediately under the mark.

6. In addition to the regular fee of 10 *pf.* ($0.024) for each piece of apparatus presented for verification, the charges for testing, stamping, etc., will be as follows:

a. For testing and stamping

Overflow pipettes delivering 200 cc. or less, 40 *pf.* ($0.096);

Overflow pipettes delivering more than 200 cc., 60 *pf.* ($0.144).

b. For mere testing

Overflow pipettes delivering 200 cc. or less, 10 *pf.* ($0.024);

Overflow pipettes delivering more than 200 cc., 30 *pf.* ($0.072).

[1] The statement in the *Ztschr. angew. Chem.* is 230 seconds; in the *Ztschr. anal. Chem.*, 200 seconds

VII. PLACE OF TESTING.

The testing of all forms of measuring instruments named will be done by the Normal-Aichungs-Commission or at the places designated for the testing of chemical measuring instruments in Article 1, Section VII of the notice of April 8, 1896 (Reichs-Gesetzbl. 1896, Beilage zu No. 9).

VIII.

1. The regulations of July 26, 1893, Section II, 4, are hereby amended so that 50 cc. and 100 cc. flasks are allowable with the graduation mark at least 50 mm. from the upper end of the neck.

2. Under Section III, 2, of the regulations of July 26, 1893, the following additional forms of apparatus are provided for:

Instruments having a total capacity of 5 cc. and graduated in 0.1 cc. divisions; and instruments having a total capacity of 10 cc. and 0.02 cc. (0.2 cc?) divisions.[1]

3. The requirements of Section IV, 2, of the regulations just mentioned are amended as follows:

Moreover, the positive or negative error allowable for the capacity limited by each mark, or between two marks must not be greater than one-half of the error permitted for the entire capacity of the instrument, in case the fractional capacity in question is less than one-half the total capacity; and the error of a fractional capacity equal to or greater than one-half of the total capacity of the instrument must not exceed the error permitted for the total capacity.

The graduation must also appear regular to the eye. In no case may adjacent smallest divisions differ from each other by more than one-fourth of the distance between the lines limiting each of these smallest divisions.

REGULATIONS FOR THE TESTING OF INSTRUMENTS FOR DETERMINING THE PERCENTAGE STRENGTH OF SUGAR SOLUTIONS.

I. There shall be admitted for testing glass thermo-saccharimeters which indicate the temperature in degrees of the centigrade thermometer, and, at a temperature of $+20^{\circ}$, the per cent. by weight of sugar contained in pure sugar solutions.

The thermometer scale of the instrument must be divided in whole or in half degrees. When the percentage scale is divided in whole or in half per cent., the thermometer shall be divided in whole degrees and otherwise in half degrees.

The entire length of the divisions of a percentage scale must not exceed 200 mm.; the length of its smallest subdivisions must be at least 1 mm.

[1] The statement in the *Ztschr. angew. Chem.* is 0.02 cc.; in the *Ztschr. anal. Chem.*, 0.2 cc.

Thirty per cent. shall be regarded as the normal range for each instrument. Hence, three kinds of instruments will be necessary: 0 to 30 per cent.; 30 to 60 per cent.; and 60 to 90 per cent. Instruments with scales of other ranges are, however, allowable. Instruments with 0.1 per cent. subdivision must not have a greater range than 20 per cent.

The thermometer scales must be made for a range of temperature from 0° to +35°. In the case of instruments graduated for whole or half per cent., the thermometer scale may be extended to 70°. The length of the smallest subdivision of the thermometer scale must be at least 1.5 mm.

II. 1. The loading of the instrument, necessary for maintaining its vertical position when floated in the solution, shall be supplied by the bulb of a thermometer.

Material for making the final adjustment of the instrument may be placed on the inside of the scale, but it must be of such a nature as to make it impossible for it to become loosened by external force or because of its own properties.

2. The outer surface of the instrument shall be regular and symmetrical with respect to its axis; its proportion shall be such that it assumes a perpendicular position when floated in a liquid.

3. The top of the spindle shall be regularly rounded and have a smooth surface with no depressions or ridges which may hinder the stamping of the instrument.

The external diameter of the body of the instrument must not exceed 28 mm., and that of the spindle must not be less than 4 mm. nor more than 7 mm.

The capillary tube of the thermometer must have no expansion above the scale, and shall only be of such length that the instrument may be heated to 75° C. without danger of breaking.

4. The paper scale must be fastened to the glass wall of the instrument in a permanent manner. Cements which loosen on warming are not permissible.

5. The upper end of the percentage scale shall be at least 15 mm. below the upper end of the spindle.

The upper end of the thermometer scale shall be at least 20 mm. below the place where the glass body of the instrument begins to contract.

6. Upon the percentage scale, in the case of division in whole per cent., the marks for the fifth and tenth per cent. shall be numbered and shall be longer than the others. In other cases the mark for each whole per cent. shall be numbered. In case of divisions for each 0.1 per cent., the marks for each half per cent. shall be longer than the other marks. The shortest marks shall extend at least one-fourth of the way around the spindle.

On the thermometer scale the marks shall run in uninter-

rupted course and shall be visible on both sides of the capillary tube; those for each fifth degree shall be longer, and those for each one-half degree shall be shorter than the others.

Each tenth degree shall be numbered.

The numbering of the marks and also the labeling of the scales shall be readily legible.

7. The per cent. scale shall extend into the expansion of the spindle leading into the body of the instrument, but shall not extend into the latter; it may, however, only bear marks so far as the spindle is cylindrical.

The marks of the thermometer scale may extend downward to within 2 mm. of the bend in the capillary tube.

8. The scales must not have appreciable error of division; adjacent subdivisions must not differ from each other by more than one-fourth of their mean length.

III. The thermometer scale shall bear the label "Degrees of the centigrade thermometer"; and the percentage scale, the label "Percentage-by-weight saccharimeter" ("*Saccharimeter nachs Gewichtspercenten*").

A manufacturer's number shall be placed at the upper end of the thermometer scale.

It is permissible to place the name and address of the manufacturer, and also the date of manufacture on one of the scales, but nothing additional may be placed thereon.

IV. The positive or negative errors permissible are as follows, according as the minor divisions of the percentage scale are for

	1 per cent.	1/2 per cent.	1/5 or 1/10 per cent.
On the thermometer scale ...	0.4°	0.4°	0.2°
On the saccharimeter scale ..	0.5 per cent.	0.25 per cent.	0.1 per cent.

The reading of the thermometer in melting ice must not undergo a greater alteration on heating to the highest temperature of the scale than one-fourth of the limit of error given above for the class of instruments to which it belongs.

On the percentage scale the reading is to be taken at the point where the plane of the surface of the liquid cuts the scale.

V. The official stamp, together with a number and the date shall be etched on the body of the instrument above the thermometer scale. A small stamp shall also be placed at the top of the spindle.

The weight of the instrument in milligrams shall be etched upon the body of the instrument.

Upon the spindle, immediately over the upper end of the percentage scale and immediately below the lowest mark thereof, marks shall be placed which extend at least half way around the spindle. The lower side of the upper mark shall lie in the plane

of the edge of the scale, and the upper side of the lower mark shall be in the plane of the lowest mark of the scale.

VI. In order to obtain true percentage readings the official table of the Normal-Aichungs-Commission must be used.

VII. The following fees have been fixed :

a. For testing and stamping

Each thermo-saccharimeter, 2 *Marks* ($0.48).

b. For mere testing

Of the thermometer scale, 10 *pf*. ($0.024) ;

Of the percentage scale, 25 *pf*. ($0.060).

If more than five points of either scale are tested when an instrument is submitted for testing and stamping, each additional place tested will be charged for at the rates given under *b*.

VIII. The testing of thermo-saccharimeters will be done by the Normal-Aichungs-Commission or by *Aichämter* designated by the Normal-Aichungs-Commission.

KAISERLICHE NORMAL-AICHUNGS-COMMISSION, HOPF.

BERLIN, July 2, 1897.

This act of the Aichungs-Commission, done five years ago, made it comparatively easy for German chemists to obtain volumetric apparatus of known form of construction and of known accuracy. A flask and a burette, tested in accordance with these regulations and bearing the official stamp of the Aichungs-Commission were exhibited at the Boston meeting of this society.

At the International Congress of Applied Chemistry, held in Brussels, in 1894, the question of uniform methods for the analysis of commercial products was discussed, and very naturally the question of international standards for measuring instruments came up at the same time. The following resolutions were adopted unanimously and an international committee was appointed to continue the work and report at the next congress.

"1. The International Congress of Applied Chemistry adopts as the international unit for the graduation and calibration of chemical apparatus, the metric liter and its decimal subdivisions.

"2. It is of the opinion that the centigrade, or Celsius, thermometer should be used to the exclusion of all others.

"3. An international commission, composed of members elected by the congress, shall be entrusted with the duty of determining the conditions of graduation, of testing, and for using chemical apparatus, particularly flasks, burettes, pipettes, and hydrometers of various sorts. This commission shall also fix the temperature at which these instruments shall be graduated. It shall elaborate a table showing the degrees Baumé, Brix, Balling, Vivien, etc., which are equivalent to the various indications of the specific gravity hydrometer ; and shall prepare a

table showing the corrections which are to be applied to the readings of various forms of hydrometers, when these readings are made at other than standard temperatures.''[1]

Preparatory to taking part in the work of the Second International Congress of Applied Chemistry, held in Paris in 1896, the Verein deutscher Chemiker appointed a committee to meet with representatives of the Aichungs-Commission and draft a statement of the German view of the question of standards for chemical measuring instruments.

A. Schmidt, of Cologne, was chosen to present the statement at the Paris congress, as the representative of the Verein deutscher Chemiker, and Prof. Weinstein attended the congress as the representative of the Aichungs-Commission.[2]

This report of the German Committee, changed to accord with the resolutions adopted by the Paris Congress, reads as follows:

PROPOSED REGULATIONS FOR THE CONSTRUCTION AND GRADUATION OF HYDROMETERS AND CHEMICAL MEASURING APPARATUS.

[Zeitschrift für angewandte Chemie, 1896, 603-607.]

A. General Considerations.

1. The unit of volume shall be the true liter and its decimal subdivisions.

2. The basis for the comparison of specific gravities (densities) shall be pure water at 4° and under normal pressure.

3. All weight determinations shall be reduced to weights *in vacuo* by use of Regnault's tables.

4. Temperature shall be expressed in degrees of the centigrade hydrogen thermometer of the International Bureau of Weights and Measures.

5. For the normal temperatures for hydrometers and chemical measuring vessels, 0°, 15°, 17.5° or 20° of the above-mentioned thermometer scale may be chosen. Tables shall be prepared by an international commission for the correction of readings to the normal temperatures.

6. Hydrometers and chemical measuring vessels shall be constructed from glass which possesses the greatest possible resistance to the action of the liquids measured. Each instrument must bear a label showing its normal temperature and unit of volume or specific gravity.

7. The length of the intervals between the marks for the smallest subdivisions of the scales of the instruments shall in all cases be greater than 1 mm.

[1] Compte-rendus du congres international de chimie appliqué, Bruxelles-Anvers, 4-11 aout, 1894, pp. 205-206.

[2] *Ztschr. angew. Chem.* (*1896*), 406, 602; (*1897*), 519.

8. In making readings at the level of a liquid, consideration must be given to the variation in the phenomena of capillarity.

9. The stems of hydrometers and the graduated parts of measuring vessels must not vary greatly from the cylindrical form.

10. The testing of hydrometers and chemical measuring vessels may be made by comparing them with carefully wrought standards, or by means of the proper weight determinations.

11. In using hydrometers and chemical measuring instruments, the same rules and methods of procedure should be followed as were used in standardizing the instruments.

B. Special Requirements.

(*a*) *Hydrometers.*

1. The scales of hydrometers may be graduated in units of specific gravity, or of the scales of Baumé, Brix, Balling, etc. For the conversion of the readings of arbitrary scales to the equivalent specific gravity, tables shall be prepared by an international commission.

2. For liquids of various capillary properties, special hydrometers shall be used, each graduated for measuring a certain liquid. Each instrument must bear a label showing for what liquid, or group of liquids of similar capillary properties, it has been graduated. The use of the same instrument for solutions of widely different capillary properties is allowable, if the proper corrections be applied to the readings.

3. Hydrometers shall be read, as a rule, at the point where the plane of the surface of the liquid cuts the stem of the instrument, without regard to the meniscus formed by capillarity. In the case of non-transparent liquids, the readings of a hydrometer which has not been graduated for working under such conditions, must be corrected to the true level of the liquid.

4. Hydrometers shall generally be provided with centigrade thermometers, whose scale shall include the zero point.

5. In order to render it certain that the position of the scale within the instrument does not change, a mark shall be placed on the stem in such a position as to be just opposite one of the limiting marks of the scale when the latter is in its correct position.

6. The maximum limit of positive or negative error of a hydrometer shall not exceed, in general, the smallest division of its scale.

(*b*) *Chemical Measuring Vessels.*

(The regulations recommended under this head are not essentially different from those of the Kaiserliche Normal-Aichungs-Commission, as given above.)

Francois Dupont read an elaborate report before the Paris congress, as the representative of the committee appointed by the Brussels congress, in the course of which he stated that no meeting of the committee had ever been held. The subject discussed by the congress seems to have been principally that of a standard temperature. A. Schmidt, of Cologne, asked that the question of temperature be left open until the Vienna congress. After a lengthy discussion, participated in principally by Belgian and French chemists, the president suggested a resolution adopting four temperatures, 4°, 15°, 20°, and 30°, with 4° as a reference temperature, and recommending correction tables for each of the four temperatures. This resolution was unanimously adopted.

The resolutions adopted relative to standards for chemical measuring instruments, as published in the official report of the congress, Vol. 5, pp. 227–228, were as follows:

"1. The unit of volume is the metric liter and its decimal subdivisions.

"2. The specific gravity of liquids is to be referred to 4° C., consequently, hydrometers must be graduated in such a manner that they read 0 or 1 000 when floated in distilled water having a temperature of 4° C.

"3. Tables for comparison of specific gravity with the different hydrometric and saccharometric degrees (Baumé, Brix, Balling, Vivien, Brix-Dupont, etc.), shall be prepared by an international commission. Tables of this sort shall be made for temperatures of 4°, 15°, 20°, and 28° C.

"Tables of corrections shall be prepared by the same commission for temperatures other than those just mentioned.

"4. All weighings shall be reduced to weights in vacuo by means of the tables deduced from the experiments of Regnault.

"5. Temperature should be expressed in degrees of the centigrade hydrogen thermometer, adopted by the International Committee of Weights and Measures.

"All other questions relating to the conditions of construction, graduation, calibration, verification, and reading of chemical measuring instruments shall be referred to the international commission.

"6. The international commission, charged with the duty of preparing tables for the comparison and correction of hydrometer readings, and of establishing regulations for standard measuring instruments, shall be composed of two subcommissions, one French and the other German. The two subcommissions shall communicate with each other and enlist the services of such delegates to the congress as care to participate in the work."

The establishment of uniform and well-defined standards for chemical measuring instruments was thus heartily approved by the

Paris congress; certain general standards were adopted as landmarks; and two commissions were created for carrying out the details of formulating international standards.

The German commission was especially active during the interim between the Paris and Vienna congresses, and presented an elaborate report at the latter, being represented by Prof. Weinstein. The recommendations for standards presented at the Paris congress by Schmidt, as the representative of the Verein deutscher Chemiker, were taken up paragraph by paragraph by the Vienna congress and adopted after slight alterations. Prof. Weinstein announced progress on the preparation of tables for the density of sugar solutions, acids, mineral oils, etc., at various temperatures, and samples of the tables were presented. These tables will be published privately.

The French commission, through its president, Démichel, presented an essentially concurrent report.

The definition of the relation of Baumé degrees to specific gravity was left to the commissions, which were continued.

A prominent auxiliary feature of the Vienna congress, and one of direct interest in this connection, was the second meeting of the International Commission on Uniform Methods of Sugar Analysis. The work of this commission is especially interesting, in view of the controversy now in progress between the U. S. Treasury Department and certain importers of sugars. This litigation involves the regulations governing the testing of sugars and is an excellent illustration of our need of well-defined legal standards for all forms of chemical measuring instruments. At the meeting of the International Commission just mentioned, the United States was represented by Drs. Wiley and Wiechmann. The work of the commission on the comparison of standard quartz plates, and the influence of temperature on the specific rotation of sucrose, were among the more important topics discussed; but, from our present point of view, the agreement of the commission to discard the Mohr flask, in favor of the true one-tenth liter flask, is of the highest interest. Hitherto, it has been necessary to keep certain flasks for sugar analysis alone, in laboratories which are otherwise equipped with volumetric apparatus graduated in accordance with the true metric system.[1]

Within a year, Belgian chemists have inaugurated a movement in the association with the view of obtaining the cooperation of the Belgian Bureau of Standards in the testing of chemical measuring instruments, and in the establishment of standards therefore. Their discussions on this subject may be found in the recent issues of the *Bulletin de L'Association Belge des Chimistes*, beginning with the number for December 1898, which con-

[1] Wiley: This Journal, 21, 73.

tains a criticism of the regulations of the Kaiserliche Normal-Aichungs-Commission by L. L. de Koninck.

The regulations of the Kaiserliche Normal-Aichungs-Commission for the construction, graduation, and verification of chemical instruments for measuring volume, while still in a stage of evolution, have stood the test of a five years' trial and the critical examination of three international congresses of chemists who are interested in all refinements of apparatus and methods consistent with practical results. Some criticisms of the minor details of these regulations have been made. Notably, by Dr. Julius Wagner in his "Maassanalytische Studien," published by Oskar Liner, Leipzig, 1898. Dr. H. P. Talbot has very kindly consented to prepare a review of Dr. Wagner's paper for this Journal, and thus bring the criticisms contained therein before the society for consideration. The most serious mistake of the Aichungs-Commission's regulations, namely, the directions for testing the minor divisions of burettes, has been corrected in the supplemental regulations issued in 1897.

There has also been some dissatisfaction among technical chemists concerning the special hydrometer for sugar solutions as constructed and tested in accordance with the Aichungs-Commission's regulations (geaichte saccharimeter). See Weinstein, "Ueber die geaichten Saccharimeter" (*Ztschr. angew. Chem.*, (*1899*), 369–70; *Chem. Centrbl.*, (*1899*), I, 1098) and the other articles therein cited written by Göckel, Bruhns, and Classen.

The regulations, as a whole, must be regarded as a long step in advance, and, by their adoption, European chemists have placed themselves in a position to obtain with readiness and without excessive cost, instruments of a high degree of accuracy and of a desirable form of construction. It now remains for American chemists to follow their example.

THE WORK OF AMERICAN CHEMISTS.

The question of the importance of legal standards for measuring instruments has frequently been raised by American chemists, and parties to suits at law and to commercial transactions are almost every day impressed with the need of standards of this kind. The Association of Official Agricultural Chemists seems to have been the first scientific body of this country to undertake seriously the work of improving the quality of our measuring instruments.

In the writer's recommendations of "subjects appropriate for investigation during the ensuing year" at the close of his report as "Reporter on Methods of Sugar Analysis of the Association of Official Agricultural Chemists for 1895," the following words were used: "A comparison of the accuracy of the various

grades of Brix spindles offered for sale by apparatus dealers. A comparison of the accuracy of the graduated glassware offered for sale by apparatus dealers, with the view of prescribing the limits of error allowable in graduated glassware to be used in official work. A similar comparison of the thermometers offered for sale by the dealers."[1] No action was taken, however, by the 1895 convention.

At the meeting of the association just named, held in 1896, a committee was appointed to consider the question of standards for volumetric apparatus, standard temperature for specific gravity determinations, etc. This committee, composed of B. W. Kilgore, C. L. Penny, and E. E. Ewell, made a preliminary report to the convention of 1897.[2] The committee was continued and its membership increased to five, G. C. Caldwell and H. W. Wiley being appointed as the additional members.

At the winter meeting of the American Chemical Society, held in Washington, 1897, the writer, acting on the suggestion of Prof. B. W. Kilgore, chairman of the committee of the Association of Official Agricultural Chemists just considered, introduced the following motion: "That a committee of five be appointed by the president to study and report upon the means by which the society can hasten the adoption of uniform systems of graduation, definite limits of accuracy, and standard methods for using all forms of measuring instruments in use in chemical laboratories. Further, that the committee be instructed to cooperate with other scientific bodies which have undertaken this work, or which may enter upon it in the future." This motion was referred to the council, and, after favorable action by that body a committee was appointed, which, after the successive resignations of Profs. Kinnicutt and Venable, is now composed of H. P. Talbot, C. E. Linebarger, G. E. Barton, Louis A. Fischer, and the writer.

The committee was promptly organized by correspondence after its members had been notified of their appointment by the secretary of the society. After much correspondence, it was agreed by a majority vote of the committee that no formal report be made at or previous to the meeting of the society held in Boston, August, 1898. In the meantime, at the suggestion of the chairman of the committee, the president of the society extended a formal invitation to the superintendent of the U. S. Coast and Geodetic Survey to present a paper at the Boston meeting of the society, in which should be described the facilities for standardizing chemical measuring instruments afforded by the U. S.

[1] See the Proceedings of the Twelfth Annual Convention of the A. O. A. C., Bulletin No. 47, Division of Chemistry, U. S. Department of Agriculture, page 154.

[2] See Proceedings Fourteenth Annual Convention of the A. O. A. C., Bulletin No. 51, Division of Chemistry, U. S. Department of Agriculture, pages 137–139 and 159–164.

Office of Standard Weights and Measures and by similar bureaus of foreign governments.

In response to the request, a paper on this subject was presented at the Boston meeting by Mr. Louis A. Fischer, of the Office of Standard Weights and Measures. By a vote of the society, this paper was referred to the Committee on Papers and Publications, with the recommendation that it be published in the Journal, as has been announced by the secretary of the society in his report of the meeting.

At the close of his paper, Mr. Fischer recommended that the society adopt the following definitions of the liter, density, and a degree of temperature:

"1. The liter, as defined by the International Committee of Weights and Measures; *viz.*, the volume of the *mass* of a kilogram of pure water at the temperature of maximum density, and under a pressure of 760 mm. of mercury.

"2. Density, defined as the ratio of the mass of a substance to that of an equal volume of pure water at its maximum density (4° C.).

"3. The centigrade degree of the hydrogen thermometer of the International Bureau of Weights and Measures."

Mr. Fischer also recommended "that the society adopt some convenient temperature, at which all volumetric apparatus shall contain their stated capacities."[1] These recommendations were referred to the committee for consideration.

A paper on "Volumetric Apparatus" was read at the Boston meeting by Mr. G. E. Barton, a member of this committee. In the course of his paper, which has already appeared in the Journal, Mr. Barton very clearly shows the need of standards for this class of measuring instruments.[2]

During sessions of the committee held at the time of the Boston meeting of the society, it was voted to limit the work of the committee for the present to the consideration of the proper form, system of graduation, limits of accuracy, manner of labeling, and methods of using volumetric apparatus.

The following motion, further defining the work of the committee for the immediate future, was presented by Prof. F. P. Venable, and adopted by a vote of the committee:

"That the members of the committee take under consideration the reports of the German Commission and the Vienna congress and, after making such corrections or additions as may be agreed upon, use this as a basis for a report to the society."

The writer presented to the committee a somewhat elaborate scheme for securing the cooperation of the members of the society in a study of the quality of chemical measuring instru-

[1] This Journal, 20, 912–927 (*1898*).

[2] *Ibid.*, 20, 731–739 (*1898*).

ments now in use, with the view of increasing the interest in the work of the committee and at the same time obtaining evidence of the directions in which reforms were most greatly needed. As the plan only received the hearty approval of one other member of the committee, it was abandoned.

The committee is now striving to bring before the council at an early date a series of recommendations which include certain definitions of fundamental standards, and the request that the U. S. Office of Standard Weights and Measures adopt regulations governing the construction, calibration, verification, etc., of chemical measuring instruments, as mentioned at the opening of this paper.

As the chairman of the committee, I take this opportunity to announce that the committee will be very glad to answer inquiries or to accept suggestions from the members of the society whenever they may find it convenient to offer them. I shall be especially pleased to see discussions of the subject of standards for volumetric apparatus or for other forms of measuring instruments, presented in this Journal. ERVIN E. EWELL.

WASHINGTON, D. C., March 7, 1899.

NEW BOOKS.

MAASSANALYTISCHE STUDIEN. Habilitationsschrift. VON Dr. JULIUS WAGNER. Leipzig: Oskar Leiner. 1898. pp. 123.

Since the adoption of the regulations of the Kaiserliche Normal-Aichungs-Commission of Berlin in June, 1893, those regulations have probably been generally accepted as representing the best results of mature thought upon questions relating to practical and desirable accuracy in the graduation and calibration of volumetric apparatus, and the precautions to be taken to ensure the preparation of trustworthy utensils. Committees appointed by three International Congresses have practically adopted the equivalent of these regulations as expressing their views, and only a few minor modifications were adopted by the Aichungs-Commission in 1897. In the little volume under consideration, Part I of which is devoted to general sources of error in volumetric analyses, Dr. Wagner has criticised certain of the conditions prescribed by the Normal-Aichungs-Commission as inadequate, and presents experimental data in support of his statements. This criticism demands some attention at this time, from its close connection with the work of the Committee on Measuring Instruments appointed by the President of the Amer-